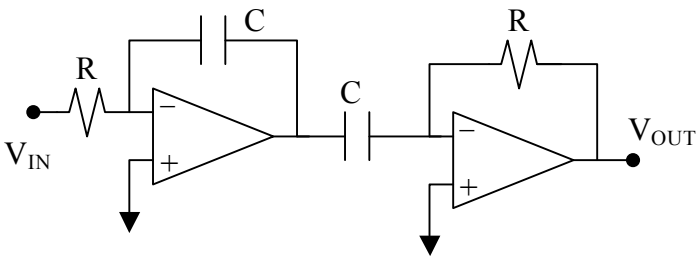
EE323 **Final Examination**
Instructor: A. Dinh

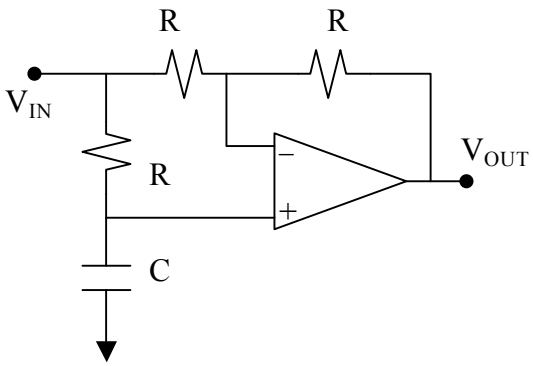
Answer 5 out of 6 questions.
Open books, open notes.
Good luck and have a Merry Christmas.

1. **Question 1: (20 marks)**

For the circuits (a) and (b) below, derive transfer functions V_{OUT}/V_{IN} as a function of frequency. For R=10K and C=15.9nF, sketch amplitude and phase response of V_{OUT}/V_{IN}.



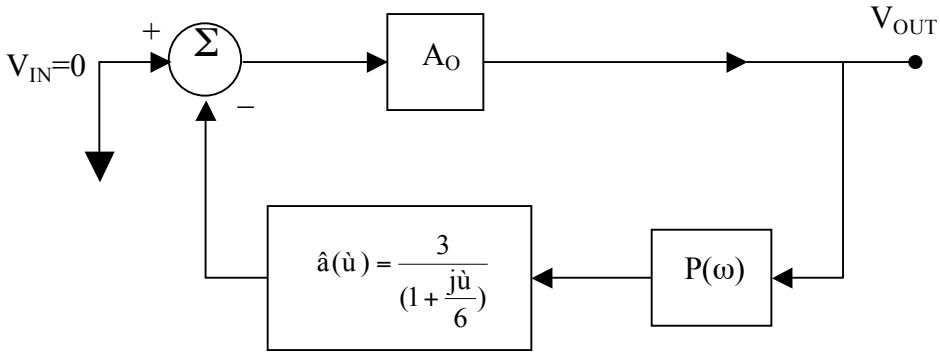
(a)



(b)

2. **Question 2: (20 marks)**

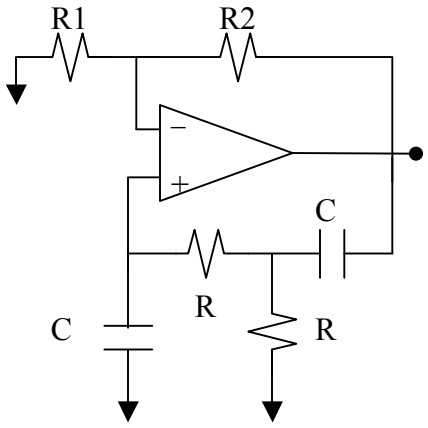
The feedback diagram shown below describes an oscillator circuit. In this case, $|P(\omega)|=0.1$ and $\angle P(\omega) = -135^{O}$ for all ω.



a) Find the frequency of oscillation.
b) Find the minimum value of A_O needed to maintain oscillation.

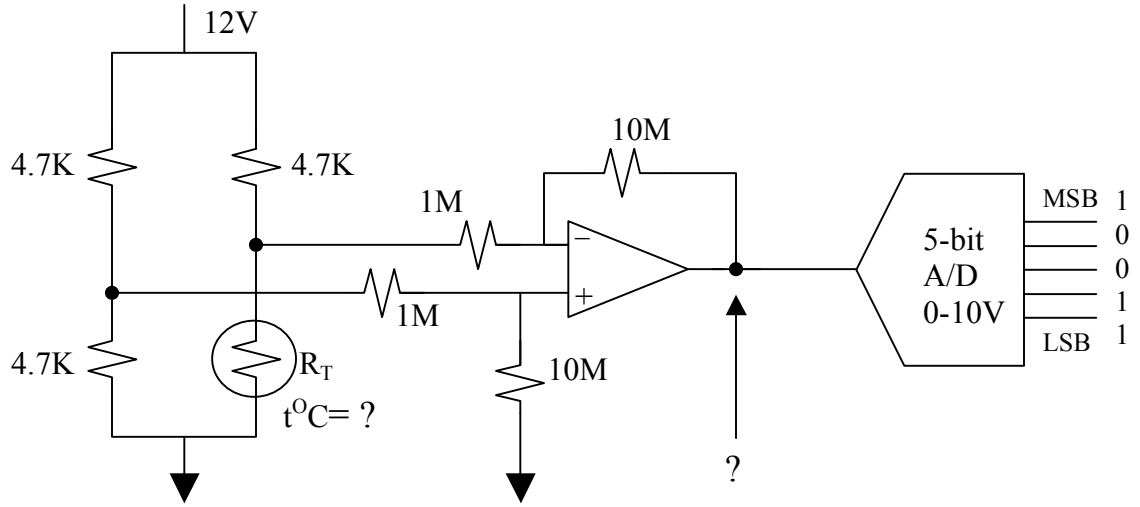
3. Question 3: (20 marks)

For the circuit below, find the loop gain L(s), L(jω), the frequency for zero loop-phase. Find R2/R1 for oscillation.



4. Question 4: (20 marks)

Consider the circuit in a temperature measurement below. The A/D is a 5-bit successive-approximation A/D converter type with an analog span of 0 to 10V, find the input voltage of the A/D converter. The thermistor, R_T, has a resistance of 2K at 20^OC and the coefficient β is assumed to be constant at 3650, find temperature of the thermistor.



5. Question 5: (20 marks)

In a digital instrumentation system to measure velocity of a fluid pipe, the A/D converter has a sampling rate of 20Ksample/second. Find the Nyquyst frequency of the analog signal from the transducer. Design an active filter for anti-aliasing purpose in front of the A/D converter. The filter should have a cut off frequency at Nyquist frequency with a selection of F_{50}/F_3 is at least 3. Since the output signal of the transducer has a wide range of frequency, no ripple is allowed in the filter passband and only 10K resistors are available to realize the filter.

Table 12-1. Design Data for Chebyshev Filters

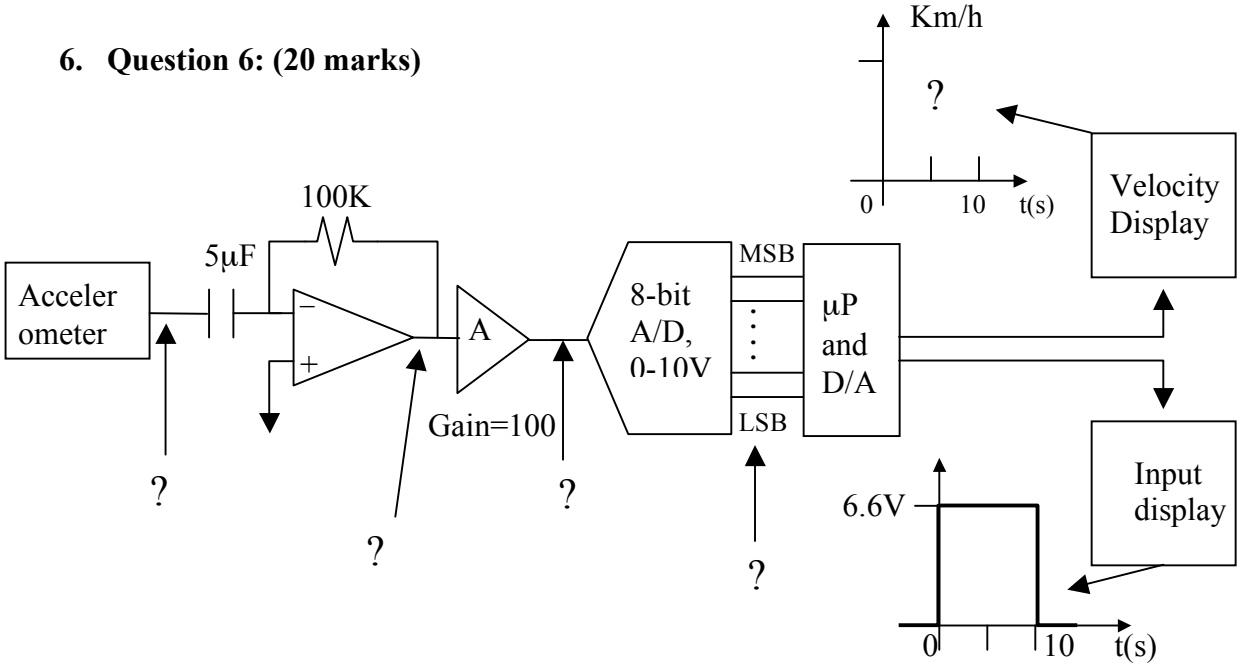
Ripple = 0 dB (Butterworth) Cutoff frequency = section frequency = 1.0

Number of sections	$\frac{F_{s0}}{F_3}$	Q Sct 1	Q Sct 2	Q Sct 3	Q Sct 4	Q Sct 5	Q Sct 6	Q Sct 7	Q Sct 8
1	17.79	0.7071							
2	4.22	0.5411	1.305						
3	2.61	0.5176	0.7071	1.932					
4	2.05	0.5098	0.6014	0.8999	2.563				
5	1.78	0.5062	0.5612	0.7071	1.101	3.196			
6	1.61	0.5043	0.5412	0.6302	0.8213	1.307	3.831		
7	1.51	0.5032	0.5297	0.5905	0.7071	0.9401	1.514	4.466	
8	1.43	0.5024	0.5225	0.5669	0.6468	0.7882	1.061	1.722	5.101

Ripple = 0.1 dB Cutoff frequency = 1.0

Number of sections	$\frac{F_{s0}}{F_3}$	F Sct 1 Q Sct 1	F Sct 2 Q Sct 2	F Sct 3 Q Sct 3	F Sct 4 Q Sct 4	F Sct 5 Q Sct 5	F Sct 6 Q Sct 6	F Sct 7 Q Sct 7	F Sct 8 Q Sct 8
1	16.59	0.9321 0.7674							
2	3.36	0.6491 0.6190	0.9491 2.185						
3	1.95	0.4688 0.5997	0.7628 1.333	0.9717 4.639					
4	1.52	0.3623 0.5934	0.6129 1.184	0.8493 2.456	0.9828 8.092				
5	1.32	0.2940 0.5906	0.5065 1.128	0.7292 2.046	0.8984 3.926	0.9887 12.54			
6	1.22	0.2469 0.5890	0.4296 1.100	0.6314 1.883	0.8038 3.123	0.9275 5.733	0.9920 17.98		
7	1.16	0.2126 0.5881	0.3723 1.084	0.5539 1.798	0.7187 2.794	0.8523 4.403	0.9459 7.871	0.9941 24.40	
8	1.12	0.1866 0.5875	0.3280 1.074	0.4920 1.748	0.6463 2.619	0.7796 3.850	0.8852 5.883	0.9582 10.34	0.9955 34.82

6. Question 6: (20 marks)



The above arrangement is used to measure velocity of a vehicle (not a good design). The waveform shown at the input display is the output of the D/A converter (data from A/D connects directly to D/A). Ignore quantization error, find the A/D output word. Sketch analog input voltage waveform at the A/D converter, the amplifier A input and the accelerometer output. The

accelerometer has an inversion factor of 0.25V/m/s^2 (i.e., 250mV corresponds to 1m/s^2), find final velocity of the vehicle if its initial velocity is 100Km/h and sketch the vehicle velocity.